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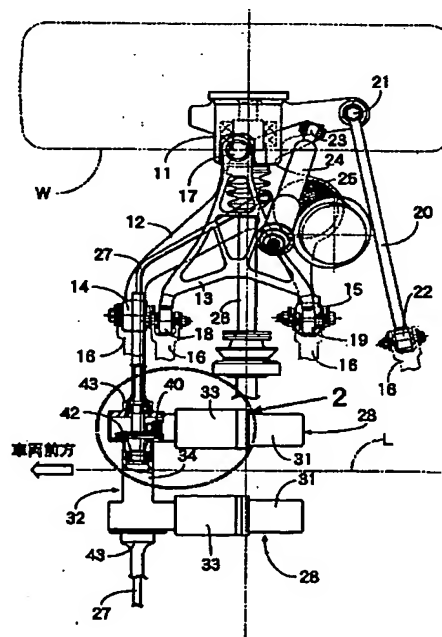
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(54) 【発明の名称】 自動車のサスペンション制御装置

(57) 【要約】

【課題】 車輪を上下動させるアクチュエータの取付位置の自由度を高める。

【解決手段】 左右の車輪Wと共に上下動する左右のロアアーム12にトーションバー27の外端部を接続し、車体中心線Lを挟んで同軸に対向する左右のトーションバー27の内端部を、各々対応するアクチュエータ28で振じるように駆動する。これによりアクチュエータ28の駆動力でトーションバー27を介して左右の車輪Wを上下動させ、ローリングやピッチングの制御を行うことができる。しかもアクチュエータ28を車体中央部に配置することができるので、アクチュエータ28が左右の車輪Wのサスペンションと干渉し難くなり、アクチュエータ28の取付位置の自由度を高めることができる。



【特許請求の範囲】

【請求項1】 左右の車輪(W)と共に上下動する部材(12)に外端部が接続され、内端部が車体中央部において同軸に対向する左右のトーションバー(27)と、左右のトーションバー(27)の内端部を各々回転駆動するアクチュエータ(28, 71)と、を備えたことを特徴とする自動車のサスペンション制御装置。

【請求項2】 前記アクチュエータ(28)は左右のモータ(31)を備え、左右のモータ(31)を左右のトーションバー(27)の一方の内端部および他方の内端部にそれぞれ接続したことを特徴とする、請求項1に記載の自動車のサスペンション制御装置。

【請求項3】 前記アクチュエータ(71)は単一のモータ(86)を備え、そのモータ(86)のステータ(87)およびロータ(88)を左右のトーションバー(27)の一方の内端部および他方の内端部にそれぞれ接続したことを特徴とする、請求項1に記載の自動車のサスペンション制御装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、アクチュエータによりトーションバーを介して左右の車輪を上下動させる自動車のサスペンション制御装置に関する。

【0002】

【従来の技術】アクチュエータで左右の車輪を上下動させるサスペンション制御装置は、特開平7-149130号公報によって公知である。このサスペンション制御装置はモータの回転を減速機構で減速して出力するアクチュエータを備えており、車輪を懸架するサスペンションアームの基端をアクチュエータの出力軸に直結し、あるいはサスペンションアームの基端を支持する支点付近をピニオンおよびセクタギヤを介して前記出力軸に接続している。従って、アクチュエータを駆動することにより、サスペンションアームを積極的に上下動させて乗り心地性能や操縦安定性能の向上を図ることができる。

【0003】

【発明が解決しようとする課題】ところで上記従来のものは、アクチュエータをサスペンションアームの近傍に設ける必要があるため、アクチュエータの取付位置の自由度が大幅に制約される問題がある。

【0004】本発明は前述の事情に鑑みてなされたもので、車輪を上下動させるアクチュエータの取付位置の自由度を高めることを目的とする。

【0005】

【課題を解決するための手段】上記目的を達成するために、請求項1に記載された発明によれば、左右の車輪と共に上下動する部材に外端部が接続され、内端部が車体中央部において同軸に対向する左右のトーションバーと、左右のトーションバーの内端部を各々回転駆動するアクチュエータとを備えたことを特徴とする自動車のサ

スペンション制御装置が提案される。

【0006】上記構成によれば、左右の車輪と共に上下動する部材に外端部を接続された左右のトーションバーの内端部を、車体中央部において同軸に対向させてアクチュエータで各々回転駆動することにより、アクチュエータの駆動力でトーションバーを介して左右の車輪を上下動させ、ローリングやピッチングの制御を行うことができる。しかもアクチュエータを車体中央部に配置することができるので、アクチュエータが左右の車輪のサスペンションと干渉し難くなり、アクチュエータの取付位置の自由度を高めることができる。

【0007】また請求項2に記載された発明によれば、請求項1の構成に加えて、前記アクチュエータは左右のモータを備え、左右のモータを左右のトーションバーの一方の内端部および他方の内端部にそれぞれ接続したことを特徴とする自動車のサスペンション制御装置が提案される。

【0008】上記構成によれば、アクチュエータの左右のモータで左右のトーションバーの内端部をそれぞれ駆動するので、左右の車輪を同位相、逆位相あるいは単独で上下動させてローリングおよびピッチングを効果的に制御することができる。

【0009】また請求項3に記載された発明によれば、請求項1の構成に加えて、前記アクチュエータは単一のモータを備え、そのモータのステータおよびロータを左右のトーションバーの一方の内端部および他方の内端部にそれぞれ接続したことを特徴とする自動車のサスペンション制御装置が提案される。

【0010】上記構成によれば、単一のモータで左右のトーションバーの内端部をそれぞれ逆方向に駆動するので、左右の車輪を逆位相で上下動させてローリングを効果的に制御することができ、しかもモータの数が1個で済むので部品点数、重量およびコストの削減に寄与することができる。

【0011】尚、実施例のロアアーム12は本発明の車輪と共に上下動する部材に対応する。

【0012】

【発明の実施の形態】以下、本発明の実施の形態を、添付図面に示した本発明の実施例に基づいて説明する。

【0013】図1～図5は本発明の第1実施例を示すもので、図1は自動車の右後輪のサスペンションの平面図、図2は図1の2部拡大断面図、図3は図2の要部拡大図、図4は図2の4-4線断面図、図5はブラネタリキャリヤ組立体の斜視図である。

【0014】図1は四輪駆動車両の右後輪のサスペンションを示すもので、車輪Wを回転自在に支持するナックル11はA型のロアアーム12およびアッパーアーム13を介して上下動可能に支持される。ロアアーム12は先端に設けたボールジョイント(図示せず)を介してナックル11の下部に接続され、基端に設けた一对のゴム

ブッシュジョイント14, 15を介して車体16に接続される。アッパーアーム13は先端に設けたボールジョイント17を介してナックル11の上部に接続され、基端に設けた一対のゴムブッシュジョイント18, 19を介して車体16に接続される。更にナックル11の後部と車体16とがラテラルリンク20および2個のゴムブッシュジョイント21, 22を介して接続される。またロアアーム12の先端側に設けたゴムブッシュジョイント23にショックアブソーバ24の下端が接続され、ロアアーム12の中央に設けたばね座に懸架ばね25の下端が支持される。エンジンの駆動力を伝達するドライブシャフト26がナックル11を貫通して車輪Wに接続される。

【0015】「へ」字状に形成されたトーションバー27は、中間の屈曲部から車体外側後方に延びる部分の外端部がロアアーム12に連結され、中間の屈曲部から車体内側に延びる部分の内端部が車体中心線Lの近傍まで延びている。従って、左右のトーションバー27, 27の内端部は車体中心線Lを挟んで同軸に対向しており、その対向部間に左右のアクチュエータ28, 28が配置される。左右のアクチュエータ28, 28は車体中心線Lを挟んで左右対称な構造を持ち、各々のアクチュエータ28が対応するトーションバー27の内端部を振るよう回転駆動する。

【0016】しかし、車両の走行に伴って車輪Wと共にナックル11が上下動し、ナックル11に接続されたロアアーム12およびアッパーアーム13が車体16に支持された基端を支点として上下動すると、ロアアーム12に接続されたショックアブソーバ24および懸架ばね25が伸縮して車輪Wの上下動が緩衝される。そしてアクチュエータ28を駆動してトーションバー27の内端部を振るよう回転させると、そのトーションバー27の外端部に接続されたロアアーム12が上下動する。従って、左右の車輪W, Wにそれぞれ対応するアクチュエータ28, 28を相互に関連して駆動することにより、車両のローリングやピッチングを積極的に制御することができる。

【0017】次に、図2～図5に基づいてアクチュエータ28の構造を説明する。

【0018】アクチュエータ28はモータ31と減速ギヤボックス32とから構成されており、減速ギヤボックス32は車体前後方向に延びる左右一対の第1ハウジング33, 33と、左右の第1ハウジング33, 33の前端間を接続して車体左右方向に延びる第2ハウジング34とを備える。第1ハウジング33は概略円筒状の部材であって、その後端にモータ31が同軸に結合される。第1ハウジング33の後端開口部から挿入されたカップ状のホルダー35にボールベアリング36を介して入力軸37が支持されており、この入力軸37の後端はモータ31の回転軸31aにスプライン結合される。減速ギ

ヤボックス32は例えば車体のリヤサブフレームに固定されるため、車輪Wの上下動によりトーションバー27が曲げ荷重を受けることになるが、その曲げ荷重はトーションバー27の弾性変形により吸収される。

【0019】入力軸37の回転は第1ハウジング33の内部に収納した3セットの遊星歯車機構Px, Py, Pzを介して減速され、第1ハウジング33の前端にボールベアリング38で支持された出力軸39に出力される。3セットの遊星歯車機構Px, Py, Pzは同軸上に直列に配置されるもので、実質的に同じ構造を備えているが、その軸方向の幅が入力側から出力側に向かって順次増加している。その理由は、減速によって伝達トルクが増加するため、その伝達トルクに耐えるようにギヤの厚さを増加させる必要があるためである。

【0020】まず、出力側の第3遊星歯車機構Pzの構造を説明する。第3遊星歯車機構Pzはサンギヤ56z、リングギヤ57z、3個のプラネタリギヤ58z…、3本のプラネタリギヤ軸59z…およびプラネタリキャリア60zを備える。プラネタリキャリア60zは、円板状の第1側板60aと、第1側板60aの外周から120°間隔で軸方向に延びる3本の脚部60b…と、脚部60b…の先端に結合される円板状の第2側板60cとを備えており、第1側板60aおよび第2側板60cの中央にそれぞれ円形の開口60d, 60eが形成される。3本のプラネタリギヤ軸59z…の両端は第1側板60aおよび第2側板60cにそれぞれ固定されており、これらプラネタリギヤ軸59z…にプラネタリギヤ58z…がニードルベアリング61z, 61zを介して支持される。プラネタリギヤ58z…の一部は、隣接する脚部60b…と一対の側板60a, 60cとによって囲まれた開口から外部に突出している。これらプラネタリキャリア60z、3本のプラネタリギヤ軸59z…およびプラネタリギヤ58z…は、第3プラネタリキャリア組立体62z（図5参照）として予め組み立てられる。

【0021】第3遊星歯車機構Pzの各プラネタリギヤ58zは、振じれ方向が相互に逆なヘリカルギヤから成る一対のギヤ半体51z, 51zを背中合わせに組み合わせ構成される。一対のギヤ半体51z, 51zには同一部品が用いられており、その一方の表裏を反転させて使用することにより、部品の種類を減少させてコストを削減することができる。

第2遊星歯車機構Pyのプラネタリキャリア60yは、第3遊星歯車機構Pzのプラネタリキャリア60zの側板60cに形成された開口60e（図5参照）の代わりに、側板60cの中央部から突出するサンギヤ軸60f（図3参照）を備える。前記サンギヤ軸60fにスプライン結合される第3遊星歯車機構Pzのサンギヤ56zは、振じれ方向が相互に逆なヘリカルギヤから成る一対のギヤ半体52z, 52zを背中合わせに組み合わせ

構成される。第3遊星歯車機構Pzのリングギヤ57zは、振じれ方向が相互に逆なヘリカルギヤから成る一対のギヤ半体53z、53zを背中合わせに組み合わせて構成されており、第1ハウジング33の内周に嵌合してピン54…で回り止めされ、第1ハウジング33の段部33aに当接して軸方向に固定される。サンギヤ56zの一対のギヤ半体52z、52zを同一部品で構成して一方の表裏を反転させて使用することにより、部品の種類を減少させてコストを削減することができ、同様にリングギヤ57zの一対のギヤ半体53z、53zを同一部品で構成して一方の表裏を反転させて使用することにより、部品の種類を減少させてコストを削減することができる。

【0022】第1遊星歯車機構Pxおよび第2遊星歯車機構Pyの構造は第3遊星歯車機構Pzの構造と実質的に同じであり、その符号は第3遊星歯車機構Pzの構成要素の符号の添字zを、それぞれxおよびyに変更したものである。また第2、第3遊星歯車機構Py、Pzのサンギヤ56y、56zはプラネタリキャリア60x、60yに設けたサンギヤ軸60f、60fにスプライン結合されるが、第1遊星歯車機構Pxのサンギヤ56xは入力軸37に一体に形成される。

【0023】第1プラネタリキャリア組立体62xのサンギヤ56xとプラネタリキャリア60x内面との間にスラストベアリング66が配置され、第2プラネタリキャリア組立体62yのサンギヤ56yとプラネタリキャリア60y内面との間にスラストベアリング67が配置され、第3プラネタリキャリア組立体62zのサンギヤ56zと出力軸39との間にスラストベアリング68が配置され、第3プラネタリキャリア組立体62zが出力軸39にスプライン結合される。そして第1～第3遊星歯車機構Px、Py、Pzのプラネタリギヤ58x…、58y…、58z…は、それぞれ対応するサンギヤ56x、56y、56zおよびリングギヤ57x、57y、57zに噛合する。

【0024】出力軸39の前端に設けた駆動ベベルギヤ40が、第2ハウジング34にボールベアリング41を介して支持したギヤ軸45に固定した従動ベベルギヤ42に噛合しており、従動ベベルギヤ42にトーションバー27の内端部がスプライン結合される。トーションバー27の内端部から所定の範囲は、第2ハウジング34の開口端に結合されたカバー43に覆われてボールベアリング44により支持される。

【0025】而して、モータ31を駆動すると、その回転軸31aの回転は入力軸37を経て第1遊星歯車機構Pxのサンギヤ56xに伝達される。すると、回転するサンギヤ56xおよび停止したリングギヤ57xに噛合するプラネタリギヤ58x…がプラネタリギヤ軸59x…回りに回転しながら、第1プラネタリキャリア組立体62xがサンギヤ56xよりも減速されて回転する。こ

のようにして第1プラネタリキャリア組立体62xが回転すると、その回転は第1プラネタリキャリア組立体62xのサンギヤ軸60fにスプライン結合された第2遊星歯車機構Pyのサンギヤ56yに伝達される。

【0026】第2遊星歯車機構Pyのサンギヤ56yの回転は減速されて第2プラネタリキャリア組立体62yに出力され、第2プラネタリキャリア組立体62yのサンギヤ軸60fにスプライン結合70された第3遊星歯車機構Pzのサンギヤ56zの回転は減速されて第3プラネタリキャリア組立体62zに出力される。その結果、第3プラネタリキャリア組立体62zにスプライン結合された出力軸39が回転する。出力軸39が回転は駆動ベベルギヤ40および従動ベベルギヤ42を介してトーションバー27の内端部に伝達され、その内端部をモータ21の回転方向に応じて振じるように回転させる。

【0027】従って、左右のトーションバー27、27を介して左右のロアアーム12、12を上下に揺動させ、左右の車輪W、Wを逆位相に上下動させることができるので、車両のローリングが検知されたときに、そのローリングを抑制することが可能となる。また左右の車輪W、Wを同位相に上下動させることも可能であり、これによりショックアブソーバ24や懸架ばね25の特性を変化させてピッチングモーメント制御やスカイフック制御を実現することができる。

【0028】このよう、減速ギヤボックス32の内部で3セットの遊星歯車機構Px、Py、Pzを直列に接続したので、コンパクトな構造で大きな減速比を確保し、トーションバー27を大きなトルクで確実に駆動することができる。また左右のアクチュエータ28、28が車体中心線Lの近傍に配置されるので、アクチュエータ28、28が左右のサスペンションと干渉するのを回避してレイアウトの自由度を大幅に増加させることができる。

【0029】また第1～第3遊星歯車機構Px、Py、Pzのプラネタリキャリア組立体62x、62y、62zは、そのプラネタリキャリア60x、60y、60zの一対の側板60a、60cが3本の脚部60b…で一体に結合されてボックス状の構造となっているため、一対の側板を3本のプラネタリギヤ軸だけで結合した従来のものに比べて剛性を大幅に高めることが可能となり、プラネタリキャリア60x、60y、60zの歪みによるトルク伝達効率の低下や、各ギヤの噛合部の摩耗による耐久性の低下を防止することができる。

【0030】また第1～第3遊星歯車機構Px、Py、Pzのサンギヤ56x、56y、56z、プラネタリギヤ58x…、58y…、58z…およびリングギヤ57x、57y、57zが、振じれ方向が相互に逆なヘリカルギヤから成る一対のギヤ半体51x～51z、52x～52z、53x～53zを背中合わせに組み合わせて

構成されるので、啮合騒音の小さいヘリカルギヤの長所をそのまま生かしながら、ヘリカルギヤの短所であるスラスト力の発生を軽減することができる。即ち、振じれ方向が相互に逆な一对のヘリカルギヤを組み合わせることにより、両ヘリカルギヤが互いに押し合うスラスト力を発生する場合には、それらスラスト力を完全に相殺することができる。また両ヘリカルギヤが相互に離反する方向のスラスト力を発生する場合には、それらスラスト力を2方向に分散させて実質的に半分に減少させることができる。これにより、前記スラスト力を支持するスラストベアリング66~68を小型化し、あるいは廃止することができる。

【0031】また振じれ方向が相互に逆な一对のヘリカルギヤを組み合わせる代わりに、山歯ギヤ（ダブルヘリカルギヤ）を採用しても同様の効果を得ることができる。しかしながら山歯ギヤは加工が面倒でコストが嵩む問題があり、それに対して本実施例のヘリカルギヤは加工が容易で低コストである。しかもプラネタリギヤ58x…、58y…、58z…の全てのギヤ半体52x…、52y…、52z…はサンギヤ56x、56y、56zおよびリングギヤ57x、57y、57zの両方に啮合するので、プラネタリギヤ58x…、58y…、58z…のギヤ半体52x…、52y…、52z…がサンギヤ56x、56y、56zおよびリングギヤ57x、57y、57zを何れか一方だけに啮合させた場合に比べて、トルク伝達容量を高めることができる。

【0032】次に、図6および図7に基づいて本発明の第2実施例を説明する。

【0033】第1実施例ではアクチュエータ28のモータ31および第1ハウジング33が車体前後方向に配置されていたが、第2実施例ではアクチュエータ28のモータ31および第1ハウジング33がトーションバー27の後部に沿って車体左右方向配置されている点で異なっている。第1ハウジング33に収納された第1~第3遊星歯車機構Px、Py、Pzの構造は第1実施例のものと同一であるが、出力軸39の回転をトーションバー27に伝達する構造が、第1ハウジング33の配置方向の変更に応じて変更されている。

【0034】即ち、第1実施例では出力軸39とトーションバー27の内端部とが直交しているために、出力軸39の回転を駆動ベベルギヤ40および従動ベベルギヤ42を介してトーションバー27に伝達していたが、第2実施例では出力軸39とトーションバー27の内端部とが平行であるために、出力軸39の回転を駆動スパーギヤ40'および従動スパーギヤ42'を介してトーションバー27に伝達している。しかし、本実施例によっても、第1実施例と同様の作用効果を奏することができる。

【0035】次に、図8および図9に基づいて本発明の第3実施例を説明する。

【0036】第1、第2実施例が左右の車輪W、Wに対応して左右一对のアクチュエータ28、28を備えているのに対し、第3実施例は左右の車輪W、Wに対応して単一のアクチュエータ71を備えており、このアクチュエータ71で左右のトーションバー27、27が相互に逆方向に振じられる。

【0037】アクチュエータ71のハウジング72は、中央左寄りの位置に小径部73aが形成された概略円筒状のハウジング本体73と、ハウジング本体73の左端部に結合されて遊星歯車機構収納室74を区画する左カバー75と、ハウジング本体73の右端部に結合される右カバー76とを備える。右側のトーションバー27はハウジング72の内部を貫通し、その内端部は遊星歯車機構収納室74の内部に延びており、左側のトーションバー27の内端部はハウジング72の左カバー75に固定されている。

【0038】遊星歯車機構収納室74の内部に収納された遊星歯車機構77は、プラネタリキャリア78と、リングギヤ79と、サンギヤ80と、複数のピニオンシャフト81…と、複数のピニオン82…とから構成されており、プラネタリキャリア78は右側のトーションバー27の内端部に固定され、リングギヤ79はハウジング本体73に固定され、サンギヤ80はハウジング本体73および右カバー76にボールベアリング83、84で支持された筒状の回転軸85に固定されている。プラネタリキャリア78に固定したピニオンシャフト81…に支持されたピニオン82…は、リングギヤ79およびサンギヤ80に同時に啮合する。

【0039】ハウジング本体73に収納されたモータ86は、ハウジング本体73の内周面に固定された永久磁石よりなるステータ87と、回転軸85の外周に固定されたコイルよりなるロータ88とを備える。

【0040】従って、モータ86を駆動するとステータ87に対してロータ88が回転し、ロータ88の回転は回転軸85を経て遊星歯車機構77の入力部材であるサンギヤ80に入力され、その出力部材であるプラネタリキャリア78から出力されて右側のトーションバー27の内端部に一方向の振じりを与える。その結果、右側のトーションバー27の振じり荷重の反力が、モータ86のステータ87からハウジング本体73および左カバー75を介して左側のトーションバー27に伝達され、そのトーションバー27の内端部に右側のトーションバー27と逆の他方向の振じりを与える。その結果、左右のトーションバー27、27は等しいトルクで相互に逆方向に振じられ、左右の車輪W、Wの一方を押し上げて他方を押し下げることにより、所望のロールモーメントを発生させることができる。

【0041】本実施例によっても、アクチュエータ71を車体中心線Lの近傍に配置することができるので、アクチュエータ71が左右のサスペンションと干渉するの

を回避してレイアウトの自由度を大幅に増加させることができる。しかも単一のアクチュエータ71で左右の車輪W、Wを上下動させることができるので、第1、第2実施例に比べて構造が簡単になり、部品点数およびコストを更に削減することができる。

【0042】以上、本発明の実施例を詳述したが、本発明はその要旨を逸脱しない範囲で種々の設計変更を行うことが可能である。

【0043】例えば、実施例ではトーションバー27、27の左右方向外端部をロアアーム12、12に接続しているが、車輪W、Wと共に上下動する部材（例えば、アッパーアーム13、13やナックル11、11）に接続することができる。また実施例では本発明を後輪のサスペンションに適用しているが、それを前輪のサスペンションに適用することも可能である。

【0044】

【発明の効果】以上のように請求項1に記載された発明によれば、左右の車輪と共に上下動する部材に外端部を接続された左右のトーションバーの内端部を、車体中央部において同軸に対向させてアクチュエータで各々回転駆動することにより、アクチュエータの駆動力でトーションバーを介して左右の車輪を上下動させ、ローリングやピッチングの制御を行うことができる。しかもアクチュエータを車体中央部に配置することができるので、アクチュエータが左右の車輪のサスペンションと干渉し難くなり、アクチュエータの取付位置の自由度を高めることができる。

【0045】また請求項2に記載された発明によれば、アクチュエータの左右のモータで左右のトーションバーの内端部をそれぞれ駆動するので、左右の車輪を同位

相、逆位相あるいは単独で上下動させてローリングおよびピッチングを効果的に制御することができる。

【0046】また請求項3に記載された発明によれば、単一のモータで左右のトーションバーの内端部をそれぞれ逆方向に駆動するので、左右の車輪を逆位相で上下動させてローリングを効果的に制御することができ、しかもモータの数が1個で済むので部品点数、重量およびコストの削減に寄与することができる。

【図面の簡単な説明】

【図1】自動車の右後輪のサスペンションの平面図

【図2】図1の2部拡大断面図

【図3】図2の要部拡大図

【図4】図2の4-4線断面図

【図5】プラネタリキャリア組立体の斜視図

【図6】第2実施例に係るアクチュエータの平面図

【図7】図6の要部拡大断面図

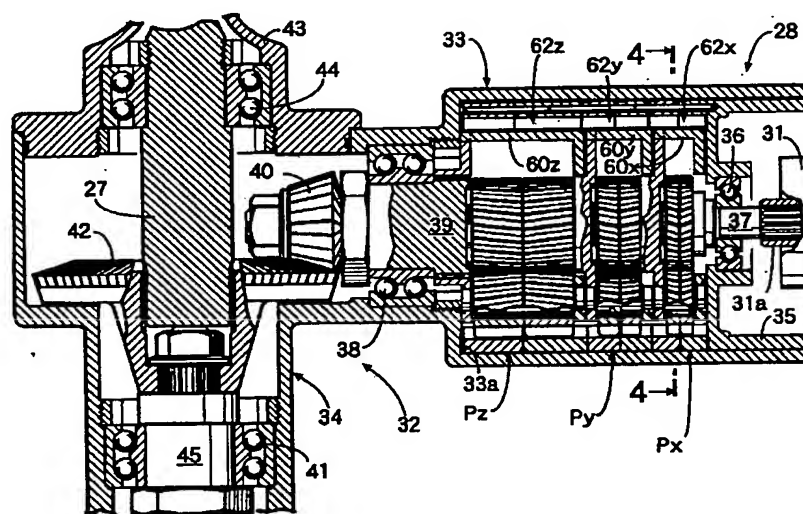
【図8】第3実施例に係る自動車の右後輪のサスペンションの平面図

【図9】図8の9-9線断面図

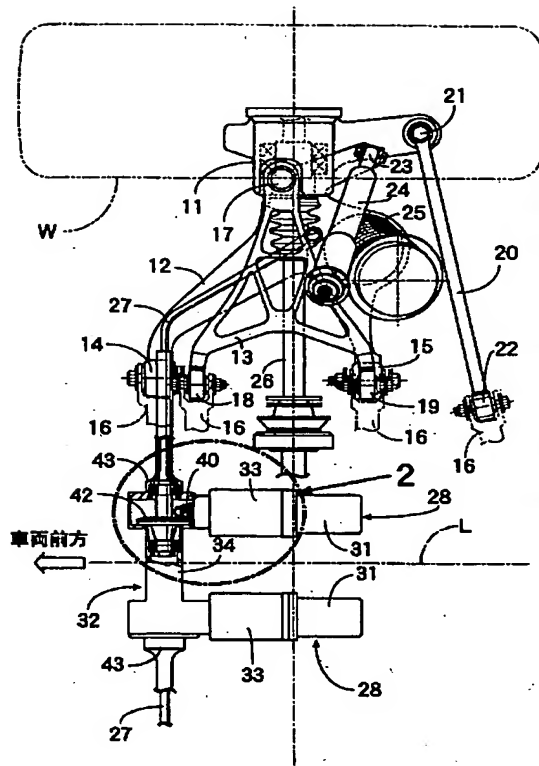
【符号の説明】

W	車輪
12	ロアアーム（車輪と共に上下動する部材）
27	トーションバー
28	アクチュエータ
31	モータ
71	アクチュエータ
86	モータ
87	ステータ
88	ロータ

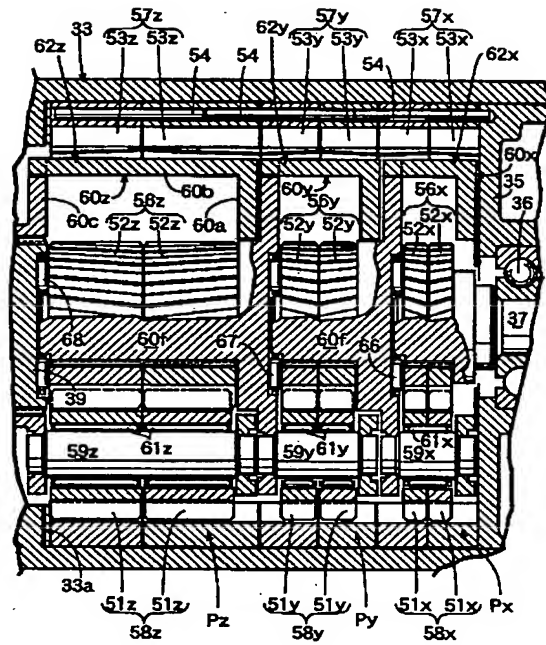
【図2】



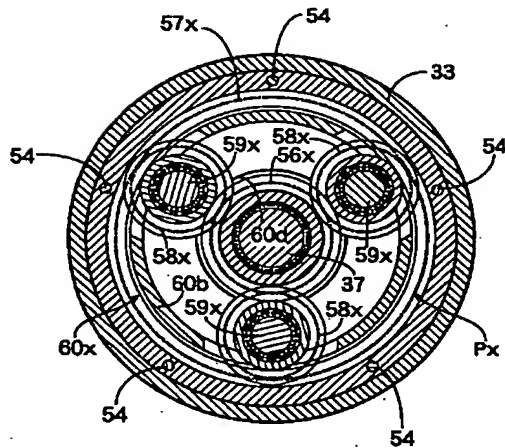
【図1】



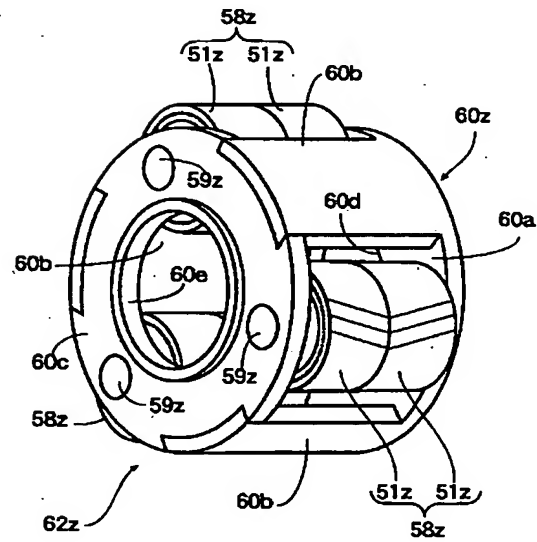
【図3】



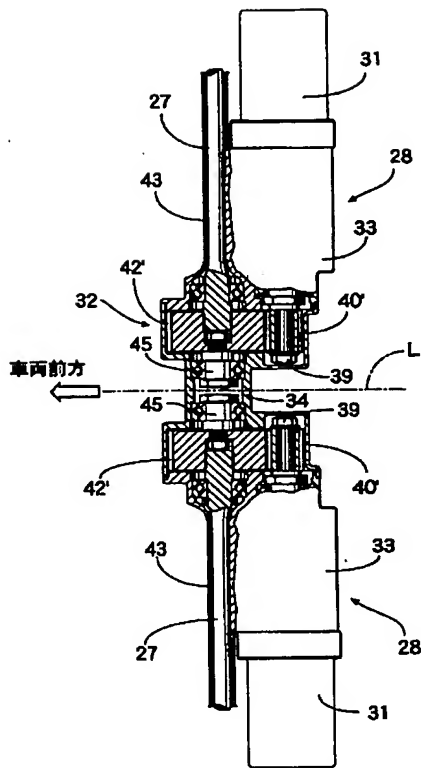
【図4】



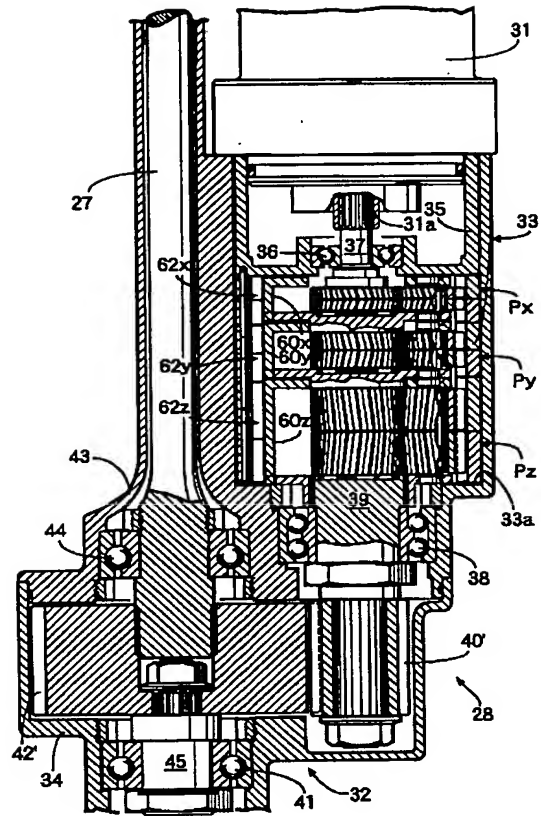
【図5】



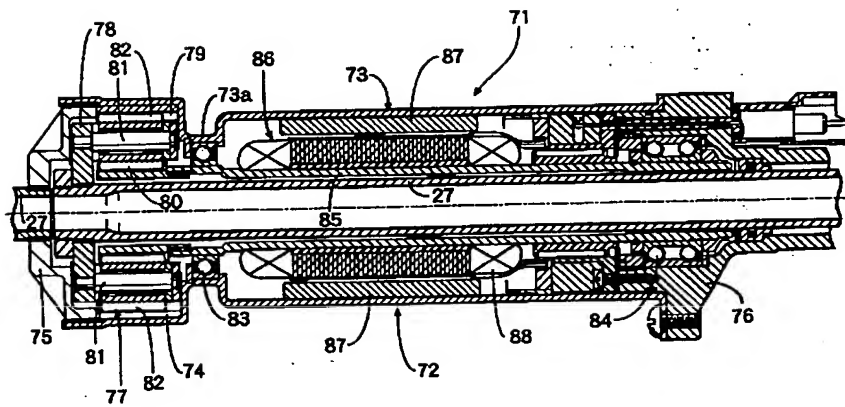
【図6】



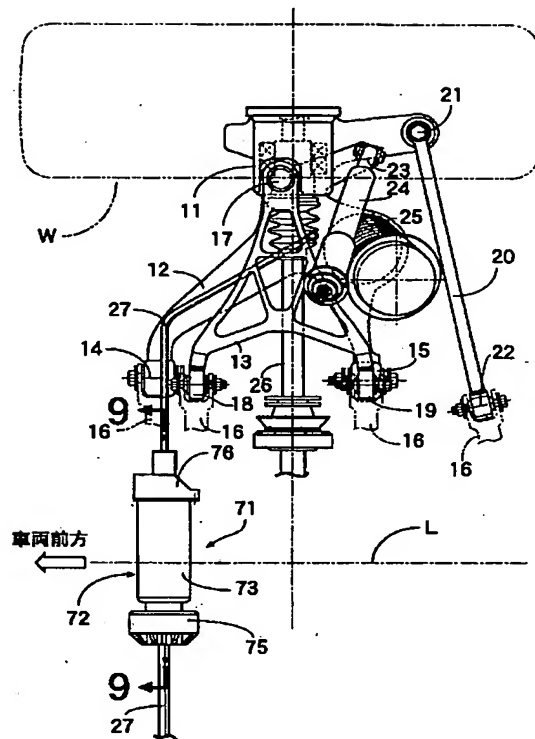
【図7】



【図9】



【図8】



フロントページの続き

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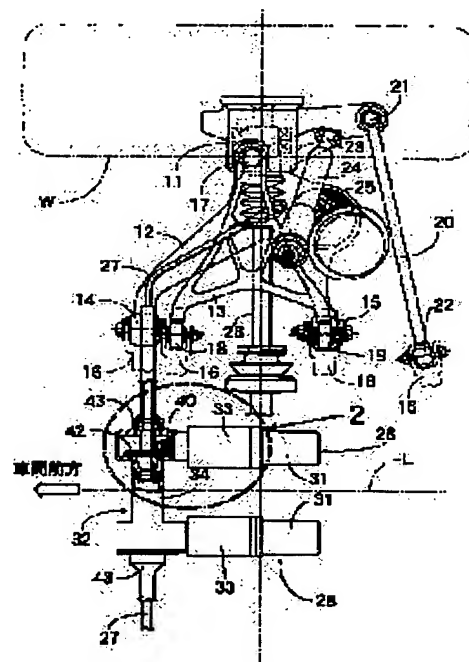
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(54) SUSPENSION CONTROL DEVICE OF AUTOMOBILE

(57)Abstract:

PROBLEM TO BE SOLVED: To improve degree of freedom of a mounting position of an actuator for vertically moving a wheel.

SOLUTION: The outer ends of right and left torsion bars 27 are connected to right and left lower arms 12 vertically moving with the right and left wheels W, an inner ends of the torsion bars 27 coaxially facing to each other on both sides of car body center line L are driven by corresponding actuators 28 while being twisted. Driving forces of the actuators 28 vertically move the right and left wheels W via the torsion bars 27, and rolling or pitching can be controlled. The actuators 28 can be disposed in the central part of the car body, so that the actuators 28 hardly interfere with a suspension of the right and left wheels W and degree of freedom of the mounting positions of the actuators 28 can be improved.



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CLAIMS

[Claim(s)]

[Claim 1] The suspension control unit of the automobile characterized by having the actuator (28 71) which carries out the rotation drive of the toe of the torsion bar spring (27) on either side with which a heel is connected to the member (12) which moves up and down with a wheel (W) on either side, and a toe counters the same axle in a car-body center section, and a torsion bar spring (27) on either side respectively.

[Claim 2] Said actuator (28) is a suspension control unit of an automobile according to claim 1 which is equipped with a motor (31) on either side, and is characterized by connecting with one toe of the torsion bar spring (27) of right and left of a motor (31) on either side, and the toe of another side, respectively.

[Claim 3] Said actuator (71) is a suspension control unit of an automobile according to claim 1 which is equipped with a single motor (86) and is characterized by connecting with one toe of the torsion bar spring (27) of right and left of the motor (the stator (87) of 86), and Rota (88), and the toe of another side, respectively.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the suspension control unit of the automobile which moves a wheel on either side up and down through a torsion bar spring with an actuator.

[0002]

[Description of the Prior Art] The suspension control unit which moves a wheel on either side up and down with an actuator is well-known by JP,7-149130,A. This suspension control device has connected to said output shaft near the supporting point which is equipped with the actuator which slows down and outputs rotation of a motor by the moderation device, and links directly the end face of the suspension arm which carries out the suspension of the wheel with the output shaft of an actuator, or supports the end face of a suspension arm through a pinion and sector gear. Therefore, by driving an actuator, a suspension arm is moved up and down positively and improvement in the degree-of-comfort engine performance or driving stability ability can be aimed at.

[0003]

[Problem(s) to be Solved by the Invention] By the way, since the above-mentioned conventional thing needs to form an actuator near the suspension arm, it has the problem on which the degree of freedom of the attaching position of an actuator is restrained sharply.

[0004] This invention was made in view of the above-mentioned situation, and aims at raising the degree of freedom of the attaching position of the actuator which moves a wheel up and down.

[0005]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, according to invention indicated by claim 1, a heel is connected to the member which moves up and down with a wheel on either side, and the suspension control unit of the automobile characterized by having the actuator which carries out the rotation drive of the toe of the torsion bar spring on either side with which a toe counters the same axle in a car-body center section, and a torsion bar spring on either side respectively is proposed.

[0006] According to the above-mentioned configuration, by making the toe of the torsion bar spring on either side by which the heel was connected to the member moving up and down counter the same axle in a car-body center section, and carrying out a rotation drive respectively with an actuator with a wheel on either side, a wheel on either side is moved up and down through a torsion bar spring with the driving force of an actuator, and control of rolling or pitching can be performed. And since an actuator can be arranged in the car-body center section, an actuator stops easily being able to interfere with the suspension of a wheel on either side, and can raise the degree of freedom of the attaching position of an actuator.

[0007] moreover -- according to invention indicated by claim 2 -- the configuration of claim 1 -- in addition, said actuator is equipped with a motor on either side, and the suspension control unit of the automobile characterized by connecting with one toe of the torsion bar spring of right and left of a motor on either side and the toe of another side, respectively is proposed.

[0008] According to the above-mentioned configuration, since the toe of a torsion bar spring on either side is driven by the motor of right and left of an actuator, respectively, a wheel on either side is moved up and down by in phase, the opposite phase, or independent, and rolling and pitching can be controlled effectively.

[0009] moreover -- according to invention indicated by claim 3 -- the configuration of claim 1 -- in addition, said actuator is equipped with a single motor and the suspension control unit of the automobile characterized by connecting with one toe of the stator of the motor and the torsion bar spring of right and left of Rota and the toe of another side, respectively is proposed.

[0010] According to the above-mentioned configuration, since the toe of a torsion bar spring on either side is driven to hard flow by the single motor, respectively, a wheel on either side is moved up and down by the opposite phase, and rolling can be controlled effectively, and since the number of motors can moreover be managed with one piece, it can contribute to reduction of components mark, weight, and cost.

[0011] In addition, the lower control arm 12 of an example corresponds to the member which moves up and

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down with the wheel of this invention.

[0012]

[Embodiment of the Invention] Hereafter, it explains based on the example of this invention which showed the gestalt of operation of this invention to the accompanying drawing.

[0013] Drawing 1 - drawing 5 show the 1st example of this invention, and, for the top view of the suspension of the right rear ring of an automobile, and drawing 2, 2 section expanded sectional view of drawing 1 and drawing 3 are [drawing 1 / the 4-4 line sectional view of drawing 2 and drawing 5 of the important section enlarged drawing of drawing 2 and drawing 4] the perspective views of a planetary carrier assembly.

[0014] Drawing 1 shows the suspension of the right rear ring of a four-wheel-drive car, and the knuckle 11 which supports Wheel W free [rotation] is supported possible [vertical movement] through the lower control arm 12 and the upper arm 13 of A mold. It connects with the lower part of a knuckle 11 through the swivel joint (not shown) formed at the tip, and a lower control arm 12 is connected to a car body 16 through the rubber bush joint 14 and 15 of the pair prepared in the end face. It connects with the upper part of a knuckle 11 through the swivel joint 17 formed at the tip, and the upper arm 13 is connected to a car body 16 through the rubber bush joint 18 and 19 of the pair prepared in the end face. Furthermore, the posterior part and car body 16 of a knuckle 11 are connected through the lateral link 20 and two rubber bush joint 21 and 22. Moreover, the lower limit of a shock absorber 24 is connected to the rubber bush joint 23 formed in the tip side of a lower control arm 12, and the lower limit of a suspension spring 25 is supported by the spring seat prepared in the center of a lower control arm 12. The drive shaft 26 which transmits engine driving force penetrates a knuckle 11, and is connected to Wheel W.

[0015] " -- passing -- " -- the heel of a part where the torsion bar spring 27 formed in the shape of a character is prolonged in middle flexion empty vehicle outside-of-the-body side back was connected with the lower control arm 12, and the toe of the part prolonged in a middle flexion empty vehicle inside-of-the-body side has extended to near the car-body center line L. Therefore, the toe of the torsion bar springs 27 and 27 on either side has countered the same axle on both sides of the car-body center line L, and the actuators 28 and 28 on either side are arranged between the opposite section. The actuators 28 and 28 on either side have symmetrical structure on both sides of the car-body center line L, and they carry out a rotation drive so that the toe of the torsion bar spring 27 with which each actuator 28 corresponds may be twisted.

[0016] A deer is carried out, a knuckle 11 moves up and down with Wheel W with transit of a car, the shock absorber 24 and suspension spring 25 which were connected to the lower control arm 12 when it moved up and down as the supporting point expand and contract the end face by which the lower control arm 12 and the upper arm 13 which were connected to the knuckle 11 were supported by the car body 16, and vertical movement of Wheel W is buffered. And if it is made to rotate so that an actuator 28 may be driven and the toe of a torsion bar spring 27 may be twisted, the lower control arm 12 connected to the heel of the torsion bar spring 27 will move up and down. Therefore, rolling and pitching of a car are positively controllable by driving the actuators 28 and 28 corresponding to the wheels W and W on either side in relation to mutual, respectively.

[0017] Next, the structure of an actuator 28 is explained based on drawing 2 - drawing 5.

[0018] The actuator 28 consists of a motor 31 and a reduction gearbox 32, and a reduction gearbox 32 is equipped with the 1st housing 33 and 33 of a Uichi Hidari pair prolonged in a car-body cross direction, and the 2nd housing 34 which connects between the front end of the 1st housing 33 and 33 on either side, and is prolonged in a car-body longitudinal direction. The 1st housing 33 is an outline cylinder-like member, and a motor 31 is combined with the back end by the same axle. The input shaft 37 is supported through the ball bearing 36 by the cup-like electrode holder 35 inserted from back end opening of the 1st housing 33, and spline association of the back end of this input shaft 37 is carried out at revolving-shaft 31a of a motor 31. Although a torsion bar spring 27 will receive a bending load by vertical movement of Wheel W since a reduction gearbox 32 is fixed to the rear subframe of a car body, the bending load is absorbed by the elastic deformation of a torsion bar spring 27.

[0019] Rotation of an input shaft 37 is slowed down through the three-set epicyclic gear devices Px, Py, and Pz contained inside the 1st housing 33, and is outputted to the output shaft 39 supported by the front end of the 1st housing 33 by the ball bearing 38. Although the three-set epicyclic gear devices Px, Py, and Pz are arranged at a serial and are substantially equipped with the same structure on the same axle, the width of face of the shaft orientations is carrying out the sequential increment toward the output side from the input side. Since transfer torque increases by moderation, the reason is for making the thickness of a gear increase so that the transfer torque may be borne.

[0020] First, the structure of the 3rd epicyclic gear device Pz of an output side is explained. The 3rd epicyclic gear device Pz is equipped with sun gear 56z, ring wheel 57z, and three planetary-gear 58z--, three planetary-gear shafts 59z--, and planetary carrier 60z. Planetary carrier 60z is equipped with disc-like 2nd side plate 60c of leg 60b-- combined at a tip with disc-like 1st side plate 60a and three leg 60b-- prolonged in shaft orientations at intervals of 120 degrees from the periphery of 1st side plate 60a, and the respectively circular

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openings 60d and 60e are formed in the center of 1st side plate 60a and 2nd side plate 60c. Three planetary-gear shafts 59z -- Both ends are being fixed to 1st side plate 60a and 2nd side plate 60c, respectively, and planetary-gear 58z-- is supported by these planetary-gear shaft 59z-- through needle bearings 61z and 61z. It has projected outside from leg of planetary-gear 58z-- which part adjoins 60b--, and opening surrounded by the side plates 60a and 60c of a pair. These planetary carrier 60z and three planetary-gear shafts 59z-- and planetary-gear 58z-- are beforehand assembled as 3rd planetary carrier assembly 62z (refer to drawing 5).

[0021] Each planetary-gear 58z of the 3rd epicyclic gear device Pz is constituted combining the gear half objects 51z and 51z of a pair with which the twist direction changes mutually from a reverse helical gear back to back. By using it, using the same components for the gear half objects 51z and 51z of a pair, and reversing the front flesh side of one of these Planetary carrier 60y of the 2nd epicyclic gear device Py which the class of components can be decreased and can reduce cost Instead of opening 60e (refer to drawing 5) formed in side plate 60c of planetary carrier 60z of the 3rd epicyclic gear device Pz, it has 60f (refer to drawing 3) of sun gear shafts which project from the center section of side plate 60c. Sun gear 56z of the 3rd epicyclic gear device Pz by which spline association is carried out is constituted back to back by 60f of said sun gear shafts combining the gear half objects 52z and 52z of a pair with which the twist direction consists mutually of a reverse helical gear. The twist direction is constituted combining the gear half objects 53z and 53z of the pair which consists mutually of a reverse helical gear back to back, it fits into the inner circumference of the 1st housing 33, and ring wheel 57z of the 3rd epicyclic gear device Pz is a pin 54. -- A baffle is carried out and it is fixed to shaft orientations in contact with step 33a of the 1st housing 33. By using it, constituting the gear half objects 52z and 52z of the pair of sun gear 56z from same components, and reversing one front flesh side The class of components can be decreased, cost can be reduced, by using it, constituting the gear half objects 53z and 53z of the pair of ring wheel 57z from same components similarly, and reversing one front flesh side, the class of components can be decreased and cost can be reduced.

[0022] The structure of the 1st epicyclic gear device Px and the 2nd epicyclic gear device Py is substantially [as the structure of the 3rd epicyclic gear device Pz] the same, and the sign changes the subscript z of the sign of the component of the 3rd epicyclic gear device Pz into x and y, respectively. Moreover, although spline association of the sun gears 56y and 56z of the 2nd and 3rd epicyclic gear devices Py and Pz is carried out at the sun gear shafts 60f and 60f prepared in the planetary carriers 60x and 60y, sun gear 56x of the 1st epicyclic gear device Px are formed in an input shaft 37 at one.

[0023] the 1st -- thrust bearing 66 is arranged between sun gear 56x and planetary carrier 60x insides of planetary carrier assembly 62x, thrust bearing 67 is arranged between sun gear 56y and the planetary carrier 60y insides of 2nd planetary carrier assembly 62y, thrust bearing 68 is arranged between sun gear 56z and the output shafts 39 of 3rd planetary carrier assembly 62z, and spline association of the 3rd planetary carrier assembly 62z is carried out at an output shaft 39. And 58z-- gears to planetary-gear 58x -- of the 1st - the 3rd epicyclic gear devices Px, Py, and Pz, and 58y--, the sun gears 56x, 56y, and 56z which correspond, respectively and ring wheels 57x, 57y, and 57z.

[0024] It has geared to the follower bevel gear 42 which the drive bevel gear 40 prepared in the front end of an output shaft 39 fixed to the gear shaft 45 supported through the ball bearing 41 in the 2nd housing 34, and spline association of the toe of a torsion bar spring 27 is carried out at the follower bevel gear 42. The range of predetermined [the toe of a torsion bar spring 27 to] is covered with the covering 43 combined with the opening edge of the 2nd housing 34, and is supported by the ball bearing 44.

[0025] If it ** and a motor 31 is driven, rotation of the revolving-shaft 31a will be transmitted to sun gear 56x of the 1st epicyclic gear device Px through an input shaft 37. then -- while planetary-gear 58x -- which gears to sun gear 56x rotating and ring wheel 57x stopped rotates to the circumference of planetary-gear shaft 59x -- the 1st -- planetary carrier assembly 62x are slowed down rather than sun gear 56x, and rotate. thus, the 1st -- if planetary carrier assembly 62x rotate -- the rotation -- the 1st -- it is transmitted to 60f of sun gear shafts of planetary carrier assembly 62x at sun gear 56y of the 2nd epicyclic gear device Py by which spline association was carried out.

[0026] Rotation of sun gear 56y of the 2nd epicyclic gear device Py is slowed down, and is outputted to 2nd planetary carrier assembly 62y, and the rotation of sun gear 56z of the 3rd epicyclic gear device Pz used as 60f of sun gear shafts of 2nd planetary carrier assembly 62y spline joint 70 is slowed down, and is outputted to 3rd planetary carrier assembly 62z. Consequently, the output shaft 39 by which spline association was carried out rotates to 3rd planetary carrier assembly 62z. An output shaft 39 makes it rotate so that rotation may be transmitted to the toe of a torsion bar spring 27 through the drive bevel gear 40 and the follower bevel gear 42 and may twist the toe according to the hand of cut of a motor 21.

[0027] Therefore, since the lower control arms 12 and 12 on either side can be made to be able to rock up and down through the torsion bar springs 27 and 27 on either side and the wheels W and W on either side can be moved up and down to an opposite phase, when rolling of a car is detected, it becomes possible to control the rolling. Moreover, it is also possible to move the wheels W and W on either side up and down in phase, the

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property of a shock absorber 24 or a suspension spring 25 can be changed by this, and pitching moment control and skyhook control can be realized.

[0028] Since the three-set epicyclic gear devices Px, Py, and Pz were connected to the serial inside this kind and a reduction gearbox 32, a big reduction gear ratio can be secured with compact structure, and a torsion bar spring 27 can be certainly driven with big torque. Moreover, since the actuators 28 and 28 on either side are arranged near the car-body center line L, it can avoid that actuators 28 and 28 interfere with a suspension on either side, and the degree of freedom of a layout can be made to increase sharply.

[0029] Moreover, the planetary carrier assemblies 62x, 62y, and 62z of the 1st – the 3rd epicyclic gear devices Px, Py, and Pz Since it is combined with one by three leg 60b-- and the side plates 60a and 60c of the pair of the planetary carriers 60x, 60y, and 60z have box-like structure, It becomes possible to raise rigidity sharply compared with the conventional thing which combined the side plate of a pair only with three planetary-gear shafts, and decline in the torque transmission efficiency by distortion of the planetary carriers 60x, 60y, and 60z and the fall of the endurance by wear of the engagement section of each gear can be prevented.

[0030] Moreover, the sun gears 56x, 56y, and 56z of the 1st – the 3rd epicyclic gear devices Px, Py, and Pz, Planetary-gear 58x --, 58y--, and 58z-- and ring wheels 57x, 57y, and 57z Since the twist direction is constituted combining the gear half objects 51x-51z of the pair which changes mutually from a reverse helical gear, 52x-52z, and 53x-53z back to back Generating of the thrust force which is the demerit of a helical gear is mitigable, employing the advantage of a helical gear with the small engagement noise efficiently as it is. That is, when generating the thrust force in which both helical gears push one another mutually when the twist direction combines the helical gear of a reverse pair mutually, these thrust force can be offset completely. Moreover, when generating the thrust force of a direction in which both helical gears desert mutually, a 2-way can be made to be able to distribute these thrust force, and one half can be decreased substantially. Thereby, the thrust bearings 66-68 which support said thrust force can be miniaturized or abolished.

[0031] Moreover, instead of the twist direction combining the helical gear of a reverse pair mutually, even if it adopts a **** gear (double helical gear), the same effectiveness can be acquired. However, a **** gear has troublesome processing and has the problem on which cost increases, and the helical gear of this example is easy to process it to it, and it is low cost. And since 52z-- gears with planetary-gear 58x --, 58y--, all gear half object 52x-- of 58z--, and 52y-- to both sun gears 56x, 56y, and 56z and the ring wheels 57x, 57y, and 57z Planetary-gear 58x --, 58y, --, 58z -- Torque-transmission capacity can be raised compared with gear half object 52x --, 52y--, and the case where 52z-- meshes sun gears 56x, 56y, and 56z and ring wheels 57x, 57y, and 57z only to either.

[0032] Next, the 2nd example of this invention is explained based on drawing 6 and drawing 7 .

[0033] Although the motor 31 and the 1st housing 33 of an actuator 28 are arranged in the 1st example at the car-body cross direction, it differs in the 2nd example in that car-body longitudinal-direction arrangement of the motor 31 and the 1st-housing 33 of an actuator 28 is carried out along with the posterior part of a torsion bar spring 27. Although the structure of the 1st contained by the 1st housing 33 – the 3rd epicyclic gear devices Px, Py, and Pz is the same as that of the thing of the 1st example, the structure of transmitting rotation of an output shaft 39 to a torsion bar spring 27 is changed according to modification of the orientation of the 1st housing 33.

[0034] That is, in the 1st example, since the output shaft 39 and the toe of a torsion bar spring 27 lay at right angles, rotation of an output shaft 39 was transmitted to the torsion bar spring 27 through the drive bevel gear 40 and the follower bevel gear 42, but in the 2nd example, since the output shaft 39 and the toe of a torsion bar spring 27 are parallel, rotation of an output shaft 39 is transmitted to the torsion bar spring 27 through drive spur-gear 40' and follower spur-gear 42'. A deer can be carried out and the same operation effectiveness as the 1st example can be done so also by this example.

[0035] Next, the 3rd example of this invention is explained based on drawing 8 and drawing 9 .

[0036] To the 1st and 2nd example being equipped with the actuators 28 and 28 of a Uichi Hidari pair corresponding to the wheels W and W on either side, the 3rd example is equipped with the single actuator 71 corresponding to the wheels W and W on either side, and the torsion bar springs 27 and 27 on either side are mutually twisted to hard flow with this actuator 71.

[0037] The housing 72 of an actuator 71 is equipped with the outline cylinder-like housing body 73 with which narrow diameter portion 73a was formed in the location of the central left, the left covering 75 which is combined with the left end section of the housing body 73, and divides the epicyclic gear device receipt room 74, and the right covering 76 combined with the right end section of the housing body 73. The right-hand side torsion bar spring 27 penetrated the interior of housing 72, the toe has extended inside the epicyclic gear device receipt room 74, and the toe of the left-hand side torsion bar spring 27 is being fixed to the left covering 75 of housing 72.

[0038] The epicyclic gear device 77 contained inside the epicyclic gear device receipt room 74 The planetary carrier 78, a ring wheel 79, a sun gear 80, and two or more pinion shaft 81 --, Consist of two or more pinion 82 –

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—, and the planetary carrier 78 is fixed to the toe of the right-hand side torsion bar spring 27. A ring wheel 79 is fixed to the housing body 73, and the sun gear 80 is being fixed to the tubed revolving shaft 85 supported by the housing body 73 and the right covering 76 by ball bearings 83 and 84. Pinion 82 — supported by pinion shaft 81 — fixed to the planetary carrier 78 gears to a ring wheel 79 and a sun gear 80 at coincidence.

[0039] The motor 86 contained by the housing body 73 is equipped with the stator 87 which consists of a permanent magnet fixed to the inner skin of the housing body 73, and Rota 88 which consists of a coil fixed to the periphery of a revolving shaft 85.

[0040] Therefore, if a motor 86 is driven, Rota 88 will rotate to a stator 87, and rotation of Rota 88 is inputted into the sun gear 80 which is the input member of the epicyclic gear device 77 through a revolving shaft 85, is outputted from the planetary carrier 78 which is the output member, and gives torsion of an one direction to the toe of the right-hand side torsion bar spring 27. Consequently, it is transmitted to the left-hand side torsion bar spring 27 through the housing body 73 and the left covering 75 from the stator 87 of a motor 86, and the reaction force of the torsion load of the right-hand side torsion bar spring 27 is contrary to the right-hand side torsion bar spring 27 to the toe of the torsion bar spring 27, and also receives torsion of a direction.

Consequently, the torsion bar springs 27 and 27 on either side are mutually twisted to hard flow with equal torque, and can generate the desired roll moment by pushing up one side of the wheels W and W on either side, and depressing another side.

[0041] Since an actuator 71 can be arranged near the car-body center line L, it can avoid that an actuator 71 interferes with a suspension on either side, and the degree of freedom of a layout can be made to increase sharply also by this example. And since the wheels W and W on either side can be moved up and down with the single actuator 71, compared with the 1st and 2nd example, structure becomes easy, and components mark and cost can be reduced further.

[0042] As mentioned above, although the example of this invention was explained in full detail, this invention can perform design changes various in the range which does not deviate from the summary.

[0043] For example, although the longitudinal-direction heel of torsion bar springs 27 and 27 is connected to lower control arms 12 and 12 in the example, it is connectable with the member (for example, the upper arms 13 and 13 and knuckles 11 and 11) which moves up and down with Wheels W and W. Moreover, although this invention is applied to the suspension of a rear wheel in the example, it is also possible to apply it to the suspension of a front wheel.

[0044]

[Effect of the Invention] According to invention indicated by claim 1 as mentioned above, by making the toe of the torsion bar spring on either side by which the heel was connected to the member which moves up and down with a wheel on either side counter the same axle in a car-body center section, and carrying out a rotation drive respectively with an actuator, a wheel on either side is moved up and down through a torsion bar spring with the driving force of an actuator, and control of rolling or pitching can be performed. And since an actuator can be arranged in the car-body center section, an actuator stops easily being able to interfere with the suspension of a wheel on either side, and can raise the degree of freedom of the attaching position of an actuator.

[0045] Moreover, according to invention indicated by claim 2, since the toe of a torsion bar spring on either side is driven by the motor of right and left of an actuator, respectively, a wheel on either side is moved up and down by in phase, the opposite phase, or independent, and rolling and pitching can be controlled effectively.

[0046] Moreover, according to invention indicated by claim 3, since the toe of a torsion bar spring on either side is driven to hard flow by the single motor, respectively, a wheel on either side is moved up and down by the opposite phase, and rolling can be controlled effectively, and since the number of motors can moreover be managed with one piece, it can contribute to reduction of components mark, weight, and cost.

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the suspension control unit of the automobile which moves a wheel on either side up and down through a torsion bar spring with an actuator.

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PRIOR ART

[Description of the Prior Art] The suspension control unit which moves a wheel on either side up and down with an actuator is well-known by JP,7-149130,A. This suspension control device has connected to said output shaft near the supporting point which is equipped with the actuator which slows down and outputs rotation of a motor by the moderation device, and links directly the end face of the suspension arm which carries out the suspension of the wheel with the output shaft of an actuator, or supports the end face of a suspension arm through a pinion and sector gear. Therefore, by driving an actuator, a suspension arm is moved up and down positively and improvement in the degree-of-comfort engine performance or driving stability ability can be aimed at.

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EFFECT OF THE INVENTION

[Effect of the Invention] According to invention indicated by claim 1 as mentioned above, by making the toe of the torsion bar spring on either side by which the heel was connected to the member which moves up and down with a wheel on either side counter the same axle in a car-body center section, and carrying out a rotation drive respectively with an actuator, a wheel on either side is moved up and down through a torsion bar spring with the driving force of an actuator, and control of rolling or pitching can be performed. And since an actuator can be arranged in the car-body center section, an actuator stops easily being able to interfere with the suspension of a wheel on either side, and can raise the degree of freedom of the attaching position of an actuator.

[0045] Moreover, according to invention indicated by claim 2, since the toe of a torsion bar spring on either side is driven by the motor of right and left of an actuator, respectively, a wheel on either side is moved up and down by in phase, the opposite phase, or independent, and rolling and pitching can be controlled effectively.

[0046] Moreover, according to invention indicated by claim 3, since the toe of a torsion bar spring on either side is driven to hard flow by the single motor, respectively, a wheel on either side is moved up and down by the opposite phase, and rolling can be controlled effectively, and since the number of motors can moreover be managed with one piece, it can contribute to reduction of components mark, weight, and cost.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] By the way, since the above-mentioned conventional thing needs to form an actuator near the suspension arm, it has the problem on which the degree of freedom of the attaching position of an actuator is restrained sharply.

[0004] This invention was made in view of the above-mentioned situation, and aims at raising the degree of freedom of the attaching position of the actuator which moves a wheel up and down.

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MEANS

[Means for Solving the Problem] In order to attain the above-mentioned purpose, according to invention indicated by claim 1, a heel is connected to the member which moves up and down with a wheel on either side, and the suspension control unit of the automobile characterized by having the actuator which carries out the rotation drive of the toe of the torsion bar spring on either side with which a toe counters the same axle in a car-body center section, and a torsion bar spring on either side respectively is proposed.

[0006] According to the above-mentioned configuration, by making the toe of the torsion bar spring on either side by which the heel was connected to the member moving up and down counter the same axle in a car-body center section, and carrying out a rotation drive respectively with an actuator with a wheel on either side, a wheel on either side is moved up and down through a torsion bar spring with the driving force of an actuator, and control of rolling or pitching can be performed. And since an actuator can be arranged in the car-body center section, an actuator stops easily being able to interfere with the suspension of a wheel on either side, and can raise the degree of freedom of the attaching position of an actuator.

[0007] moreover -- according to invention indicated by claim 2 -- the configuration of claim 1 -- in addition, said actuator is equipped with a motor on either side, and the suspension control unit of the automobile characterized by connecting with one toe of the torsion bar spring of right and left of a motor on either side and the toe of another side, respectively is proposed.

[0008] According to the above-mentioned configuration, since the toe of a torsion bar spring on either side is driven by the motor of right and left of an actuator, respectively, a wheel on either side is moved up and down by in phase, the opposite phase, or independent, and rolling and pitching can be controlled effectively.

[0009] moreover -- according to invention indicated by claim 3 -- the configuration of claim 1 -- in addition, said actuator is equipped with a single motor and the suspension control unit of the automobile characterized by connecting with one toe of the stator of the motor and the torsion bar spring of right and left of Rota and the toe of another side, respectively is proposed.

[0010] According to the above-mentioned configuration, since the toe of a torsion bar spring on either side is driven to hard flow by the single motor, respectively, a wheel on either side is moved up and down by the opposite phase, and rolling can be controlled effectively, and since the number of motors can moreover be managed with one piece, it can contribute to reduction of components mark, weight, and cost.

[0011] In addition, the lower control arm 12 of an example corresponds to the member which moves up and down with the wheel of this invention.

[0012]

[Embodiment of the Invention] Hereafter, it explains based on the example of this invention which showed the gestalt of operation of this invention to the accompanying drawing.

[0013] Drawing 1 - drawing 5 show the 1st example of this invention, and, for the top view of the suspension of the right rear ring of an automobile, and drawing 2, 2 section expanded sectional view of drawing 1 and drawing 3 are [drawing 1 / the 4-4 line sectional view of drawing 2 and drawing 5 of the important section enlarged drawing of drawing 2 and drawing 4] the perspective views of a planetary carrier assembly.

[0014] Drawing 1 shows the suspension of the right rear ring of a four-wheel-drive car, and the knuckle 11 which supports Wheel W free [rotation] is supported possible [vertical movement] through the lower control arm 12 and the upper arm 13 of A mold. It connects with the lower part of a knuckle 11 through the swivel joint (not shown) formed at the tip, and a lower control arm 12 is connected to a car body 16 through the rubber bush joint 14 and 15 of the pair prepared in the end face. It connects with the upper part of a knuckle 11 through the swivel joint 17 formed at the tip, and the upper arm 13 is connected to a car body 16 through the rubber bush joint 18 and 19 of the pair prepared in the end face. Furthermore, the posterior part and car body 16 of a knuckle 11 are connected through the lateral link 20 and two rubber bush joint 21 and 22. Moreover, the lower limit of a shock absorber 24 is connected to the rubber bush joint 23 formed in the tip side of a lower control arm 12, and the lower limit of a suspension spring 25 is supported by the spring seat prepared in the center of a lower control arm 12. The drive shaft 26 which transmits engine driving force penetrates a knuckle 11, and is connected to Wheel W.

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[0015] “-- passing --” -- the heel of a part where the torsion bar spring 27 formed in the shape of a character is prolonged in middle flexion empty vehicle outside-of-the-body side back was connected with the lower control arm 12, and the toe of the part prolonged in a middle flexion empty vehicle inside-of-the-body side has extended to near the car-body center line L. Therefore, the toe of the torsion bar springs 27 and 27 on either side has countered the same axle on both sides of the car-body center line L, and the actuators 28 and 28 on either side are arranged between the opposite section. The actuators 28 and 28 on either side have symmetrical structure on both sides of the car-body center line L, and they carry out a rotation drive so that the toe of the torsion bar spring 27 with which each actuator 28 corresponds may be twisted.

[0016] A deer is carried out, a knuckle 11 moves up and down with Wheel W with transit of a car, the shock absorber 24 and suspension spring 25 which were connected to the lower control arm 12 when it moved up and down as the supporting point expand and contract the end face by which the lower control arm 12 and the upper arm 13 which were connected to the knuckle 11 were supported by the car body 16, and vertical movement of Wheel W is buffered. And if it is made to rotate so that an actuator 28 may be driven and the toe of a torsion bar spring 27 may be twisted, the lower control arm 12 connected to the heel of the torsion bar spring 27 will move up and down. Therefore, rolling and pitching of a car are positively controllable by driving the actuators 28 and 28 corresponding to the wheels W and W on either side in relation to mutual, respectively.

[0017] Next, the structure of an actuator 28 is explained based on drawing 2 - drawing 5.

[0018] The actuator 28 consists of a motor 31 and a reduction gearbox 32, and a reduction gearbox 32 is equipped with the 1st housing 33 and 33 of a Uichi Hidari pair prolonged in a car-body cross direction, and the 2nd housing 34 which connects between the front end of the 1st housing 33 and 33 on either side, and is prolonged in a car-body longitudinal direction. The 1st housing 33 is an outline cylinder-like member, and a motor 31 is combined with the back end by the same axle. The input shaft 37 is supported through the ball bearing 36 by the cup-like electrode holder 35 inserted from back end opening of the 1st housing 33, and spline association of the back end of this input shaft 37 is carried out at revolving-shaft 31a of a motor 31. Although a torsion bar spring 27 will receive a bending load by vertical movement of Wheel W since a reduction gearbox 32 is fixed to the rear subframe of a car body, the bending load is absorbed by the elastic deformation of a torsion bar spring 27.

[0019] Rotation of an input shaft 37 is slowed down through the three-set epicyclic gear devices Px, Py, and Pz contained inside the 1st housing 33, and is outputted to the output shaft 39 supported by the front end of the 1st housing 33 by the ball bearing 38. Although the three-set epicyclic gear devices Px, Py, and Pz are arranged at a serial and are substantially equipped with the same structure on the same axle, the width of face of the shaft orientations is carrying out the sequential increment toward the output side from the input side. Since transfer torque increases by moderation, the reason is for making the thickness of a gear increase so that the transfer torque may be borne.

[0020] First, the structure of the 3rd epicyclic gear device Pz of an output side is explained. The 3rd epicyclic gear device Pz is equipped with sun gear 56z, ring wheel 57z, and three planetary-gear 58z--, three planetary-gear shafts 59z--, and planetary carrier 60z. Planetary carrier 60z is equipped with disc-like 2nd side plate 60c of leg 60b-- combined at a tip with disc-like 1st side plate 60a and three leg 60b-- prolonged in shaft orientations at intervals of 120 degrees from the periphery of 1st side plate 60a, and the respectively circular openings 60d and 60e are formed in the center of 1st side plate 60a and 2nd side plate 60c. Three planetary-gear shafts 59z -- Both ends are being fixed to 1st side plate 60a and 2nd side plate 60c, respectively, and planetary-gear 58z-- is supported by these planetary-gear shaft 59z-- through needle bearings 61z and 61z. It has projected outside from leg of planetary-gear 58z-- which part adjoins 60b--, and opening surrounded by the side plates 60a and 60c of a pair. These planetary carrier 60z and three planetary-gear shafts 59z-- and planetary-gear 58z-- are beforehand assembled as 3rd planetary carrier assembly 62z (refer to drawing 5).

[0021] Each planetary-gear 58z of the 3rd epicyclic gear device Pz is constituted combining the gear half objects 51z and 51z of a pair with which the twist direction changes mutually from a reverse helical gear back to back. By using it, using the same components for the gear half objects 51z and 51z of a pair, and reversing the front flesh side of one of these Planetary carrier 60y of the 2nd epicyclic gear device Py which the class of components can be decreased and can reduce cost Instead of opening 60e (refer to drawing 5) formed in side plate 60c of planetary carrier 60z of the 3rd epicyclic gear device Pz, it has 60f (refer to drawing 3) of sun gear shafts which project from the center section of side plate 60c. Sun gear 56z of the 3rd epicyclic gear device Pz by which spline association is carried out is constituted back to back by 60f of said sun gear shafts combining the gear half objects 52z and 52z of a pair with which the twist direction consists mutually of a reverse helical gear. The twist direction is constituted combining the gear half objects 53z and 53z of the pair which consists mutually of a reverse helical gear back to back, it fits into the inner circumference of the 1st housing 33, and ring wheel 57z of the 3rd epicyclic gear device Pz is a pin 54. -- A baffle is carried out and it is fixed to shaft orientations in contact with step 33a of the 1st housing 33. By using it, constituting the gear half objects 52z and 52z of the pair of sun gear 56z from same components, and reversing one front flesh side The class of

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components can be decreased, cost can be reduced, by using it, constituting the gear half objects 53z and 53z of the pair of ring wheel 57z from same components similarly; and reversing one front flesh side, the class of components can be decreased and cost can be reduced.

[0022] The structure of the 1st epicyclic gear device Px and the 2nd epicyclic gear device Py is substantially [as the structure of the 3rd epicyclic gear device Pz] the same, and the sign changes the subscript z of the sign of the component of the 3rd epicyclic gear device Pz into x and y, respectively. Moreover, although spline association of the sun gears 56y and 56z of the 2nd and 3rd epicyclic gear devices Py and Pz is carried out at the sun gear shafts 60f and 60f prepared in the planetary carriers 60x and 60y, sun gear 56x of the 1st epicyclic gear device Px are formed in an input shaft 37 at one.

[0023] the 1st — thrust bearing 66 is arranged between sun gear 56x and planetary carrier 60x insides of planetary carrier assembly 62x, thrust bearing 67 is arranged between sun gear 56y and the planetary carrier 60y insides of 2nd planetary carrier assembly 62y, thrust bearing 68 is arranged between sun gear 56z and the output shafts 39 of 3rd planetary carrier assembly 62z, and spline association of the 3rd planetary carrier assembly 62z is carried out at an output shaft 39. And 58z— gears to planetary-gear 58x — of the 1st — the 3rd epicyclic gear devices Px, Py, and Pz, and 58y—, the sun gears 56x, 56y, and 56z which correspond, respectively and ring wheels 57x, 57y, and 57z.

[0024] It has geared to the follower bevel gear 42 which the drive bevel gear 40 prepared in the front end of an output shaft 39 fixed to the gear shaft 45 supported through the ball bearing 41 in the 2nd housing 34, and spline association of the toe of a torsion bar spring 27 is carried out at the follower bevel gear 42. The range of predetermined [the toe of a torsion bar spring 27 to] is covered with the covering 43 combined with the opening edge of the 2nd housing 34, and is supported by the ball bearing 44.

[0025] If it ** and a motor 31 is driven, rotation of the revolving-shaft 31a will be transmitted to sun gear 56x of the 1st epicyclic gear device Px through an input shaft 37. then — while planetary-gear 58x — which gears to sun gear 56x rotating and ring wheel 57x stopped rotates to the circumference of planetary-gear shaft 59x — the 1st — planetary carrier assembly 62x are slowed down rather than sun gear 56x, and rotate. thus, the 1st — if planetary carrier assembly 62x rotate — the rotation — the 1st — it is transmitted to 60f of sun gear shafts of planetary carrier assembly 62x at sun gear 56y of the 2nd epicyclic gear device Py by which spline association was carried out.

[0026] Rotation of sun gear 56y of the 2nd epicyclic gear device Py is slowed down, and is outputted to 2nd planetary carrier assembly 62y, and the rotation of sun gear 56z of the 3rd epicyclic gear device Pz used as 60f of sun gear shafts of 2nd planetary carrier assembly 62y spline joint 70 is slowed down, and is outputted to 3rd planetary carrier assembly 62z. Consequently, the output shaft 39 by which spline association was carried out rotates to 3rd planetary carrier assembly 62z. An output shaft 39 makes it rotate so that rotation may be transmitted to the toe of a torsion bar spring 27 through the drive bevel gear 40 and the follower bevel gear 42 and may twist the toe according to the hand of cut of a motor 21.

[0027] Therefore, since the lower control arms 12 and 12 on either side can be made to be able to rock up and down through the torsion bar springs 27 and 27 on either side and the wheels W and W on either side can be moved up and down to an opposite phase, when rolling of a car is detected, it becomes possible to control the rolling. Moreover, it is also possible to move the wheels W and W on either side up and down in phase, the property of a shock absorber 24 or a suspension spring 25 can be changed by this, and pitching moment control and skyhook control can be realized.

[0028] Since the three-set epicyclic gear devices Px, Py, and Pz were connected to the serial inside this kind and a reduction gearbox 32, a big reduction gear ratio can be secured with compact structure, and a torsion bar spring 27 can be certainly driven with big torque. Moreover, since the actuators 28 and 28 on either side are arranged near the car-body center line L, it can avoid that actuators 28 and 28 interfere with a suspension on either side, and the degree of freedom of a layout can be made to increase sharply.

[0029] Moreover, the planetary carrier assemblies 62x, 62y, and 62z of the 1st — the 3rd epicyclic gear devices Px, Py, and Pz Since it is combined with one by three leg 60b— and the side plates 60a and 60c of the pair of the planetary carriers 60x, 60y, and 60z have box-like structure, It becomes possible to raise rigidity sharply compared with the conventional thing which combined the side plate of a pair only with three planetary-gear shafts, and decline in the torque transmission efficiency by distortion of the planetary carriers 60x, 60y, and 60z and the fall of the endurance by wear of the engagement section of each gear can be prevented.

[0030] Moreover, the sun gears 56x, 56y, and 56z of the 1st — the 3rd epicyclic gear devices Px, Py, and Pz, Planetary-gear 58x —, 58y—, and 58z— and ring wheels 57x, 57y, and 57z Since the twist direction is constituted combining the gear half objects 51x-51z of the pair which changes mutually from a reverse helical gear, 52x-52z, and 53x-53z back to back Generating of the thrust force which is the demerit of a helical gear is mitigable, employing the advantage of a helical gear with the small engagement noise efficiently as it is. That is, when generating the thrust force in which both helical gears push one another mutually when the twist direction combines the helical gear of a reverse pair mutually, these thrust force can be offset completely. Moreover,

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when generating the thrust force of a direction in which both helical gears desert mutually, a 2-way can be made to be able to distribute these thrust force, and one half can be decreased substantially. Thereby, the thrust bearings 66-68 which support said thrust force can be miniaturized or abolished.

[0031] Moreover, instead of the twist direction combining the helical gear of a reverse pair mutually, even if it adopts a **** gear (double helical gear), the same effectiveness can be acquired. However, a **** gear has troublesome processing and has the problem on which cost increases, and the helical gear of this example is easy to process it to it, and it is low cost. And since 52z--- gears with planetary-gear 58x ---, 58y---, all gear half object 52x--- of 58z---, and 52y--- to both sun gears 56x, 56y, and 56z and the ring wheels 57x, 57y, and 57z Planetary-gear 58x ---, 58y, ---, 58z --- Torque-transmission capacity can be raised compared with gear half object 52x ---, 52y---, and the case where 52z--- meshes sun gears 56x, 56y, and 56z and ring wheels 57x, 57y, and 57z only to either.

[0032] Next, the 2nd example of this invention is explained based on drawing 6 and drawing 7.

[0033] Although the motor 31 and the 1st housing 33 of an actuator 28 are arranged in the 1st example at the car-body cross direction, it differs in the 2nd example in that car-body longitudinal-direction arrangement of the motor 31 and the 1st housing 33 of an actuator 28 is carried out along with the posterior part of a torsion bar spring 27. Although the structure of the 1st contained by the 1st housing 33 - the 3rd epicyclic gear devices Px, Py, and Pz is the same as that of the thing of the 1st example, the structure of transmitting rotation of an output shaft 39 to a torsion bar spring 27 is changed according to modification of the orientation of the 1st housing 33.

[0034] That is, in the 1st example, since the output shaft 39 and the toe of a torsion bar spring 27 lay at right angles, rotation of an output shaft 39 was transmitted to the torsion bar spring 27 through the drive bevel gear 40 and the follower bevel gear 42, but in the 2nd example, since the output shaft 39 and the toe of a torsion bar spring 27 are parallel, rotation of an output shaft 39 is transmitted to the torsion bar spring 27 through drive spur-gear 40' and follower spur-gear 42'. A deer can be carried out and the same operation effectiveness as the 1st example can be done so also by this example.

[0035] Next, the 3rd example of this invention is explained based on drawing 8 and drawing 9.

[0036] To the 1st and 2nd example being equipped with the actuators 28 and 28 of a Uichi Hidari pair corresponding to the wheels W and W on either side, the 3rd example is equipped with the single actuator 71 corresponding to the wheels W and W on either side, and the torsion bar springs 27 and 27 on either side are mutually twisted to hard flow with this actuator 71.

[0037] The housing 72 of an actuator 71 is equipped with the outline cylinder-like housing body 73 with which narrow diameter portion 73a was formed in the location of the central left, the left covering 75 which is combined with the left end section of the housing body 73, and divides the epicyclic gear device receipt room 74, and the right covering 76 combined with the right end section of the housing body 73. The right-hand side torsion bar spring 27 penetrated the interior of housing 72, the toe has extended inside the epicyclic gear device receipt room 74, and the toe of the left-hand side torsion bar spring 27 is being fixed to the left covering 75 of housing 72.

[0038] The epicyclic gear device 77 contained inside the epicyclic gear device receipt room 74 The planetary carrier 78, a ring wheel 79, a sun gear 80, and two or more pinion shaft 81 ---, Consist of two or more pinion 82 ---, and the planetary carrier 78 is fixed to the toe of the right-hand side torsion bar spring 27. A ring wheel 79 is fixed to the housing body 73, and the sun gear 80 is being fixed to the tubed revolving shaft 85 supported by the housing body 73 and the right covering 76 by ball bearings 83 and 84. Pinion 82 --- supported by pinion shaft 81 --- fixed to the planetary carrier 78 gears to a ring wheel 79 and a sun gear 80 at coincidence.

[0039] The motor 86 contained by the housing body 73 is equipped with the stator 87 which consists of a permanent magnet fixed to the inner skin of the housing body 73, and Rota 88 which consists of a coil fixed to the periphery of a revolving shaft 85.

[0040] Therefore, if a motor 86 is driven, Rota 88 will rotate to a stator 87, and rotation of Rota 88 is inputted into the sun gear 80 which is the input member of the epicyclic gear device 77 through a revolving shaft 85, is outputted from the planetary carrier 78 which is the output member, and gives torsion of an one direction to the toe of the right-hand side torsion bar spring 27. Consequently, it is transmitted to the left-hand side torsion bar spring 27 through the housing body 73 and the left covering 75 from the stator 87 of a motor 86, and the reaction force of the torsion load of the right-hand side torsion bar spring 27 is contrary to the right-hand side torsion bar spring 27 to the toe of the torsion bar spring 27, and also receives torsion of a direction.

Consequently, the torsion bar springs 27 and 27 on either side are mutually twisted to hard flow with equal torque, and can generate the desired roll moment by pushing up one side of the wheels W and W on either side, and depressing another side.

[0041] Since an actuator 71 can be arranged near the car-body center line L, it can avoid that an actuator 71 interferes with a suspension on either side, and the degree of freedom of a layout can be made to increase sharply also by this example. And since the wheels W and W on either side can be moved up and down with the

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single actuator 71, compared with the 1st and 2nd example, structure becomes easy, and components mark and cost can be reduced further.

[0042] As mentioned above, although the example of this invention was explained in full detail, this invention can perform design changes various in the range which does not deviate from the summary.

[0043] For example, although the longitudinal-direction heel of torsion bar springs 27 and 27 is connected to lower control arms 12 and 12 in the example, it is connectable with the member (for example, the upper arms 13 and 13 and knuckles 11 and 11) which moves up and down with Wheels W and W. Moreover, although this invention is applied to the suspension of a rear wheel in the example, it is also possible to apply it to the suspension of a front wheel.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The top view of the suspension of the right rear ring of an automobile

[Drawing 2] 2 section expanded sectional view of drawing 1

[Drawing 3] The important section enlarged drawing of drawing 2

[Drawing 4] The 4-4 line sectional view of drawing 2

[Drawing 5] The perspective view of a planetary carrier assembly

[Drawing 6] The top view of the actuator concerning the 2nd example

[Drawing 7] The important section expanded sectional view of drawing 6

[Drawing 8] The top view of the suspension of the right rear ring of the automobile concerning the 3rd example

[Drawing 9] The 9-9 line sectional view of drawing 8

[Description of Notations]

W Wheel

12 Lower Control Arm (Member Which Moves Up and Down with Wheel)

27 Torsion Bar Spring

28 Actuator

31 Motor

71 Actuator

86 Motor

87 Stator

88 Rota

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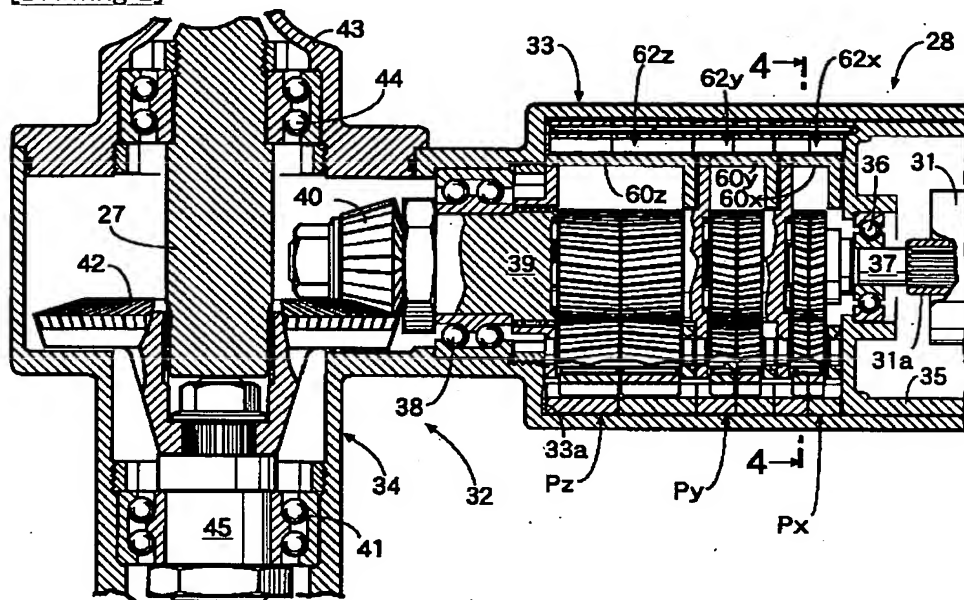
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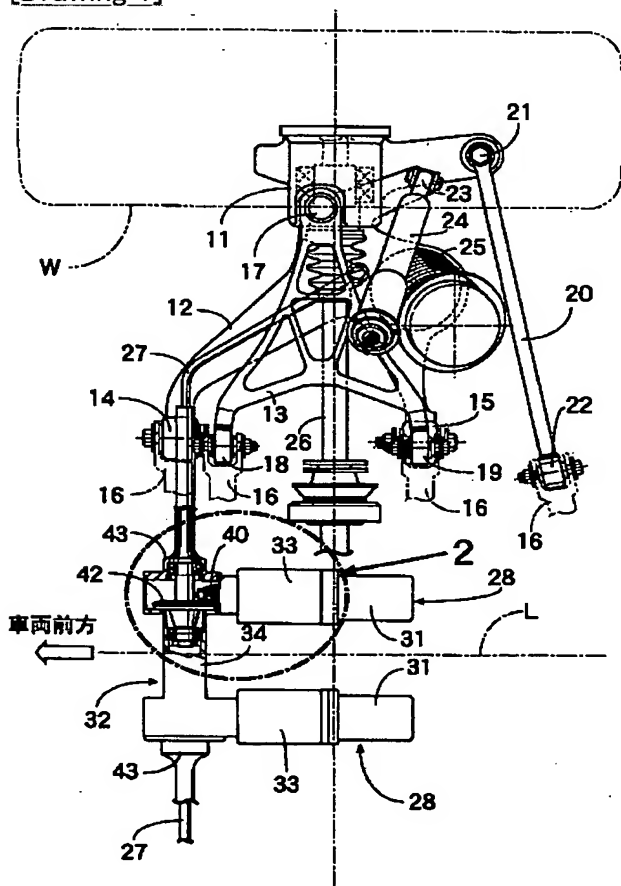
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DRAWINGS

[Drawing 2]

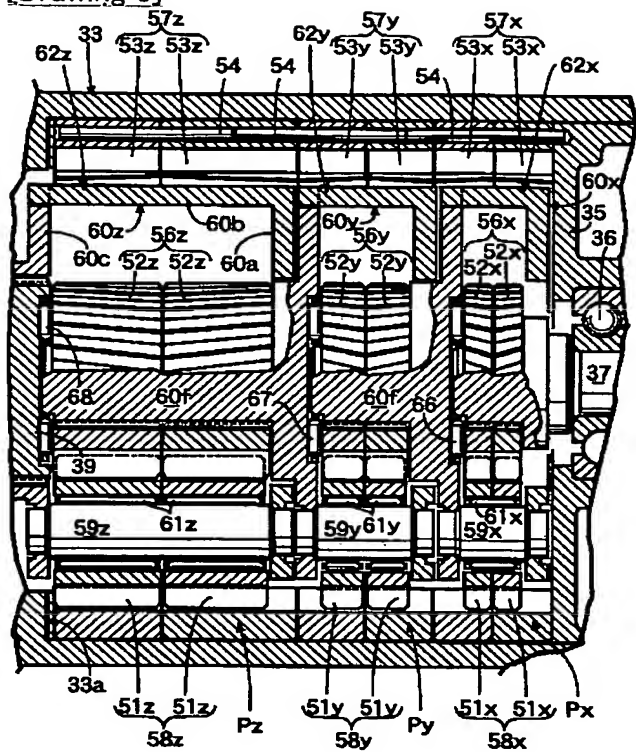


[Drawing 1]

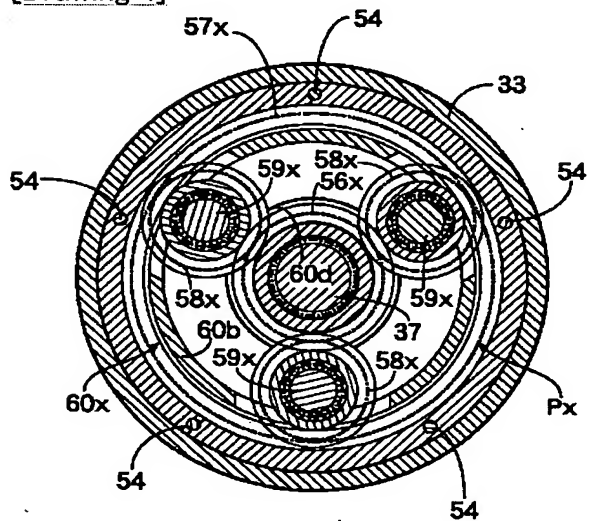


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[Drawing 3]

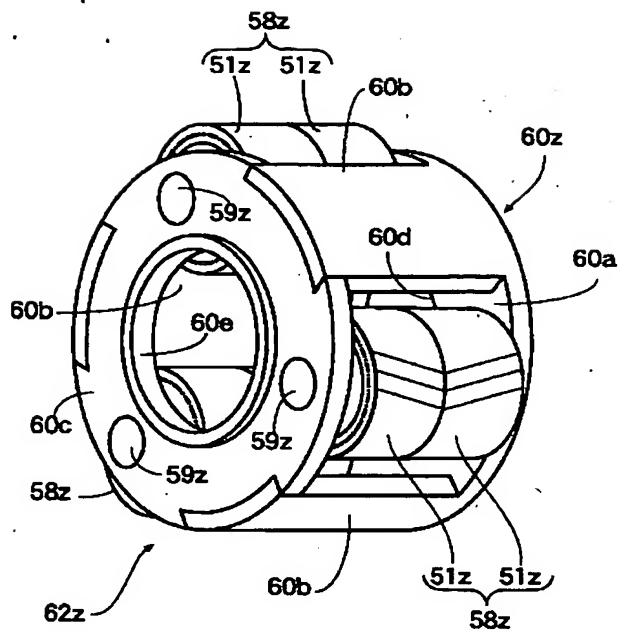


[Drawing 4]

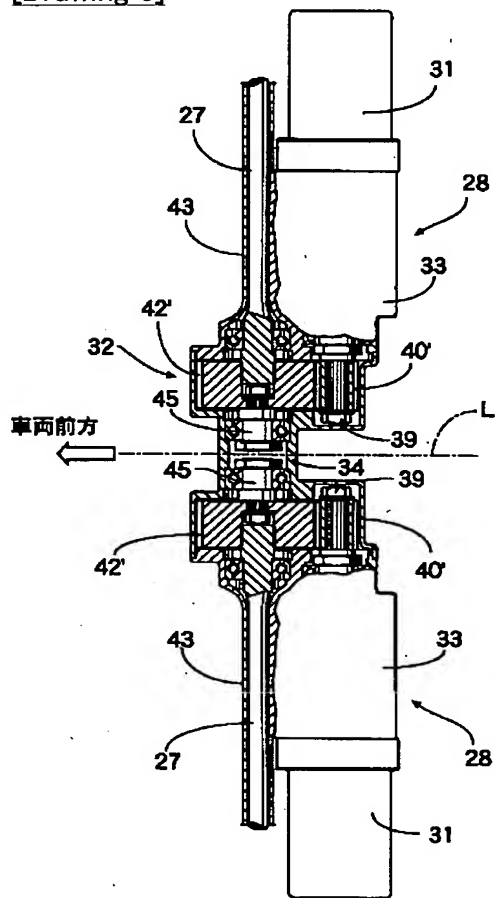


[Drawing_5]

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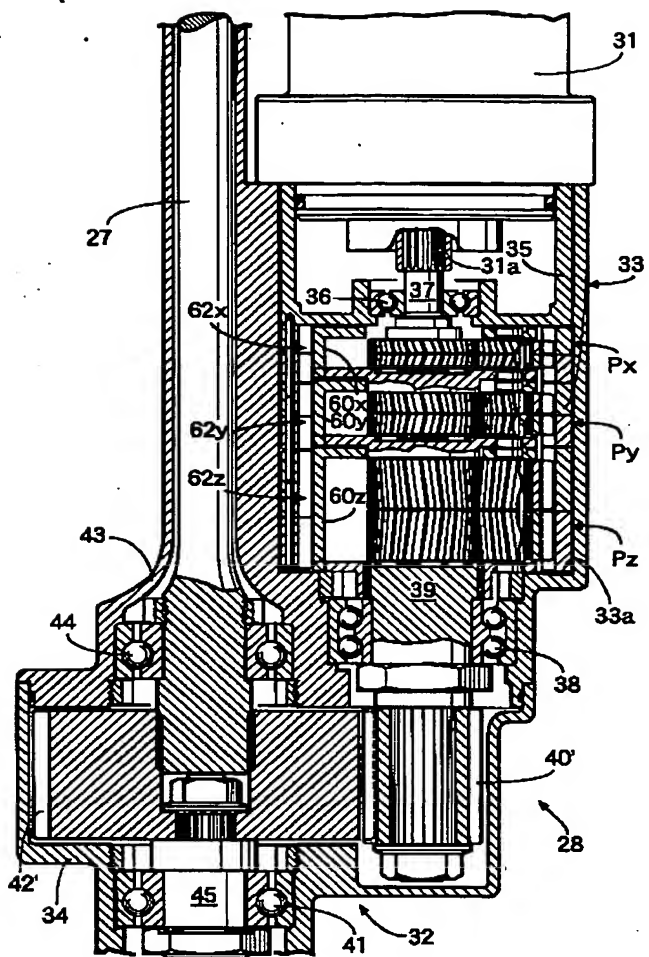


[Drawing 6]

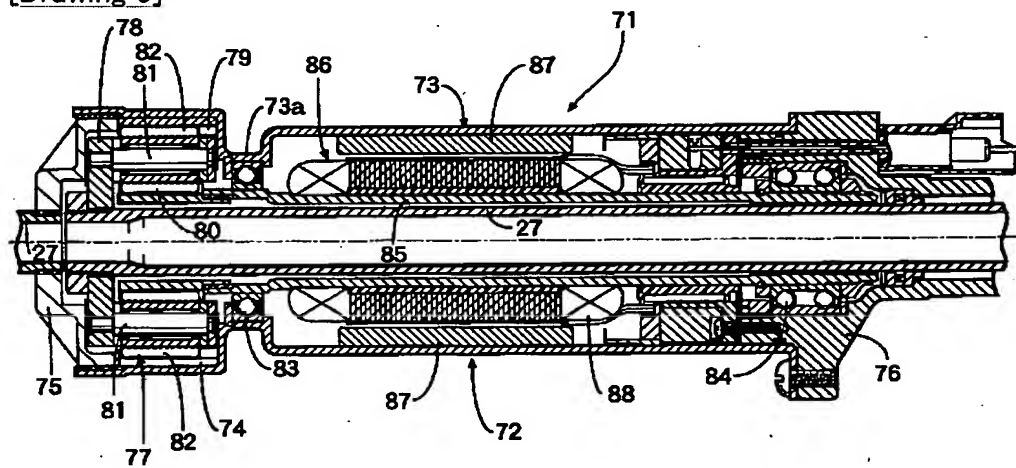


[Drawing 7]

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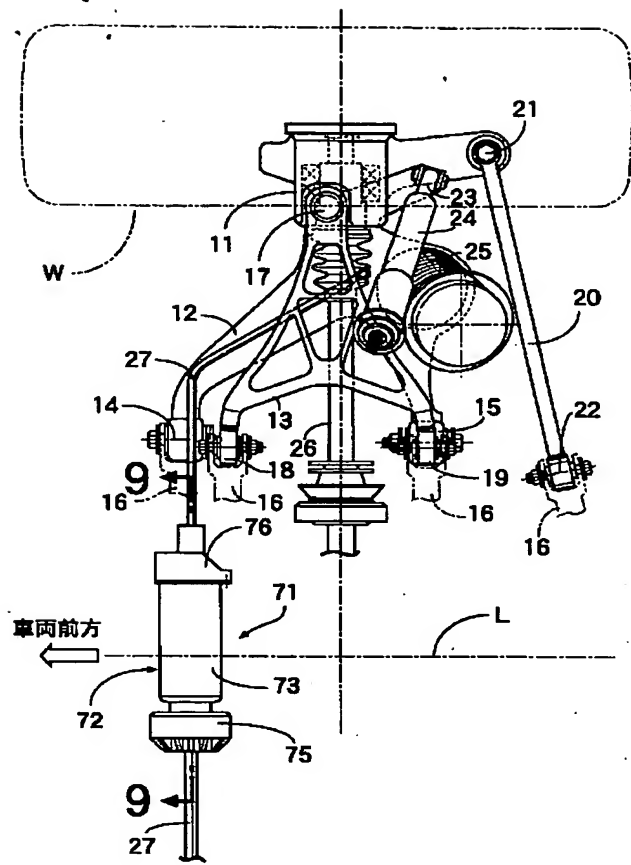


[Drawing 9]



[Drawing 8]

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